

FLUKE®

Service Manual

• **PM5150**
*Arbitrary
Waveform
Generator
20 MS/s*

ARBITRARY WAVEFORM GENERATOR 20 MS/s

PM 5150

SERVICE MANUAL

4822 872 15026
950927



Please note

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

Bitte beachten

Bei Schriftwechsel über dieses Gerät wird gebeten, die Typennummer und die Gerätenummer anzugeben. Diese befinden sich auf dem Typenschild an der Rückseite des Gerätes.

Noter s.v.p.

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez toujours indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Important

As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Wichtig

Da das Gerät ein elektrisches Betriebsmittel ist, darf die Bedienung nur durch eingewiesenes Personal erfolgen. Wartung und Reparatur dürfen nur von geschulitem, fach- und sachkundigem Personal durchgeführt werden.

Important

Comme l'instrument est un équipement électrique, le service doit être assuré par du personnel qualifié. De même, l'entretien et les réparations sont à confier aux personnes suffisamment qualifiées.

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SALES & SERVICE CENTRES

1 SAFETY INSTRUCTIONS

WARNING

These service instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than specified in the Operating Instructions unless you are fully qualified to do so.

Read these pages carefully before installation and use of the instrument.

The following clauses contain information, cautions, and warnings which must be followed to ensure safe operation and to keep the instrument in a safe condition. Adjustment, maintenance, and repair to the instrument shall be carried out only by qualified personnel.

1.1 SAFETY PRECAUTIONS

For the correct and safe use of this instrument it is essential that both operating and servicing personnel follow generally accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual. Where necessary, the warning and caution statements and/or symbols are marked on the apparatus.

1.2 CAUTION AND WARNING STATEMENTS

CAUTION

Is used to indicate correct operating or maintenance procedures to prevent damage to or destruction of the equipment or other property.

WARNING

Calls attention to a potential danger that requires correct procedures or practices to prevent personal injury.

1.3 SYMBOLS



Protective earth (black symbol on yellow background)
(grounding) terminal

1.4 IMPAIRED SAFETY PROTECTION

Whenever it is likely that safety protection has been impaired, the instrument must be disconnected from power and be secured against any unintended operation. The matter should then be referred to qualified technicians. Safety protection is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

1.5 GENERAL CLAUSES

WARNING

The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can be dangerous.

The instrument shall be disconnected from all voltage sources before it is opened.

Capacitors inside the instrument can hold their charge even if the instrument has been removed from all voltage sources.

WARNING

Any interruption of the protective earth conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.

Components which are important for the safety of the instrument may only be replaced by components obtained through your local Fluke/Philips organization (see also Chapter 7).

After repair and maintenance in the primary circuit, safety inspection and tests, as mentioned in Chapter 6, must be performed.

2 LINE VOLTAGE SETTING AND FUSES

The safety instructions in previous chapters must be followed.

Before plugging in the power cord make sure that the instrument is set to the local line voltage.

WARNING

If the power cord has to be adapted to the local situation, such adaption should be done by a qualified person only.

On delivery from the factory the instrument is set to one of the following line voltages:

Instrument Version	Instrument Code No.	Line Voltage Setting	Delivered Power Cord
PM 5150/xx1	9445 051 50xx1	220 V	Universal Europe
PM 5150/xx3	9445 051 50xx3	120 V	North America
PM 5150/xx4	9445 051 50xx4	240 V	England (U.K.)
PM 5150/xx5	9445 051 50xx5	220 V	Switzerland
PM 5150/xx8	9445 051 50xx8	240 V	Australia

The set line voltage and the corresponding fuse rating are indicated on the rear panel.

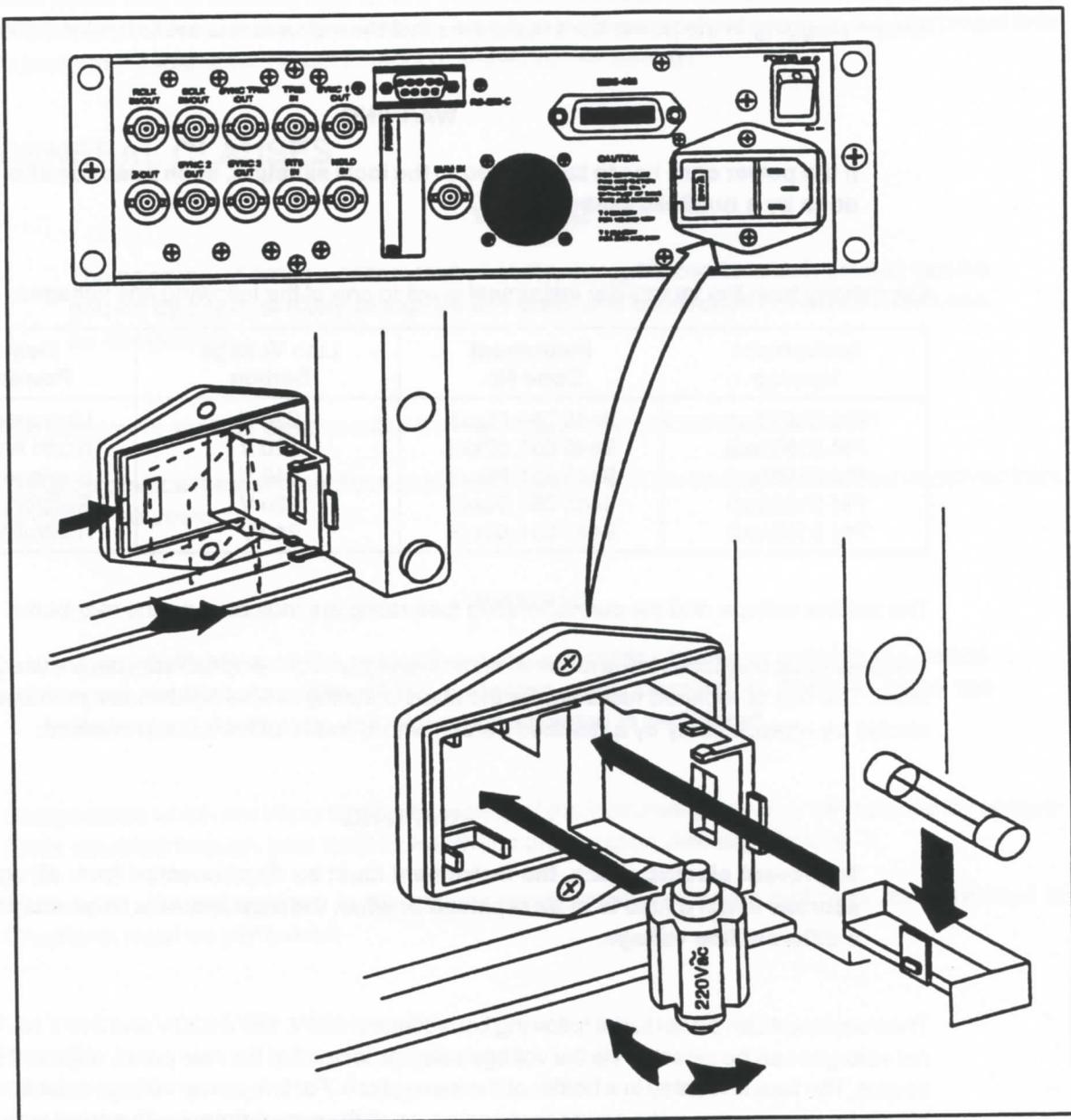
Make sure that only fuses of the required current rating, and of the specified type, are used for replacement. The use of repaired fuses and/or the short circuiting of fuse holders are prohibited. The fuse should be replaced only by a qualified person who is aware of the hazard involved.

WARNING

To prevent electric shock, the instrument must be disconnected from all voltage sources when a fuse is to be replaced or when the instrument is to be adapted to a different line voltage.

The instrument can be set to the following line voltages: 100 V, 120 V, 220 V and 240 V ac. These nominal voltages can be selected via the voltage selector, located at the rear panel, adjacent to the power socket. The fuse is located in a holder at the same place. For line power voltage selection or replacement of the fuse, remove the power cord and pry open the compartment with a small screwdriver (see drawing next page).

Select one of the voltage ranges, as appropriate, by turning the selector. If necessary, insert the correct fuse (T0.25A or T0.5A) into the fuse holder instead of the original one.



3 SERVICE PROCEDURE

The complete instrument is repaired preferably in the Supply Center Hamburg, mostly on complete board exchange. Only the Power Supply and the Keyboard/Display board are available as spare parts and those parts, which are listed in Chapter 7. So only limited service work can be performed in the countries. The board set, consisting of the Analog Board 3, the Digital Board 1, and for instruments PM 5150/551 with the Sequencer Board 2 under the Digital Board, is not available as spare part.

The reason for this central repair is the complexity of the central board set and the required test equipment and test software needed.

For instruments to be sent to Hamburg for repair, a retour reference number must be asked via your local Fluke/Philips organisation of your country.

We guarantee a turn-around time of 10 working days for instruments sent in for repair (instrument in – instrument out).

For verification of the technical performance of the instrument, see Chapter 4, 'Performance Test', in this Service Manual, also Chapter 7 of the Operating Manual.

4 PERFORMANCE TEST

4.1 INTRODUCTION

A performance test may be used as an acceptance test when the instrument is received. If the test fails, an indication is given that repair and/or adjustment is required.

The PM 5150 must be warmed up with all covers in place for at least 20 minutes prior to starting the tests.

4.2 RECOMMENDED TEST EQUIPMENT

- 50 Ω feedthrough termination; PM 9585
- AC rms voltmeter; Fluke 8840A-05
- DC voltmeter; PM 2535
- Distortion analyzer; HP 339A
- Frequency counter; PM 6665
- Wideband oscilloscope ($t_r < 3.5$ ns); PM 3295

NOTE

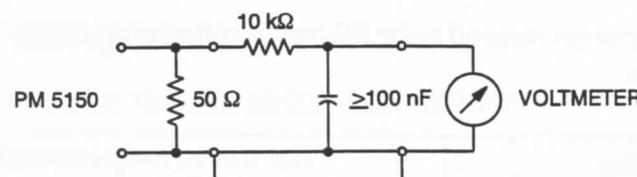
All test equipment has an output error of plus or minus a specified amount. Be sure to subtract this error from the Test Requirement tolerances listed in the following tests. Refer to the manufacturer's specifications in the opening sections of the instrument manual.

4.3 PERFORMANCE VERIFICATION

4.3.1 Amplitude Accuracy and DC Offset Error Test

Test Equipment:

- AC rms voltmeter
- DC voltmeter
- 50 Ω feedthrough termination
- Lowpass filter (see illustration below)



4.3.1.1 Amplitude Accuracy Test

Generator Settings:

- WAVE STD WAVE, L = 1000, N = 1
- SAMPLE CLOCK 1 MHz
- MODE CONT
- OUTPUT ON
- FILTER OFF
- OFFSET 0 V

Output Socket:

- Front panel OUTPUT

Condition:

- Generator output 50Ω terminated, AC rms voltmeter connected

AC Amplitude Setting	Test Result Requirements AC Output rms
10.00 V	1.743 V to 1.792 V
1.000 V	169.7 mV to 183.8 mV
100.0 mV	16.44 mV to 18.91 mV

4.3.1.2 DC Offset Error Test

Generator Settings:

- Same as above

Output Socket:

- Front panel OUTPUT

Condition:

- Generator output 50Ω terminated, DC voltmeter instead of AC rms voltmeter connected

Remark:

Take care that the DC voltmeter does not respond to the AC portion of the tested signal. If necessary insert lowpass filter shown above.

AC Amplitude Setting	Test Result Requirements AC Output rms
10.00 V	-150 mV to +150 mV

4.3.2 THD + Noise (SINAD)

Test Equipment:

- 50 Ω feedthrough termination
- Distortion analyzer

Generator Settings:

▪ WAVE	STD WAVE, L = 1000, SIN, N = 1
▪ SAMPLE CLOCK	20 MHz
▪ MODE	CONT
▪ OUTPUT	ON
▪ FILTER	ON
▪ AMPLITUDE	1 V

Condition:

- Generator output 50 Ω terminated, distortion analyzer set to 80 kHz measurement bandwidth

Test requirement:

- THD + Noise < -62 dBc

4.3.3 Sample Clock Frequency

Test Equipment:

- Frequency counter

Generator Settings:

▪ SAMPLE CLOCK	20 MHz
▪ MODE	CONT

Output Socket:

- Rear panel SCLK

Condition:

- Open-circuit output, counter set to high input impedance

Test requirement:

- SCLK: 19.99900 MHz to 20.00100 MHz

4.3.4 Rise/Fall Time

Test Equipment:

- 50 W feedthrough termination, wideband oscilloscope

Generator Settings:

▪ WAVE	STD WAVE, L = 1000, SRQ, N = 10
▪ SAMPLE CLOCK	20 MHz
▪ MODE	CONT
▪ OUTPUT	ON
▪ FILTER	OFF
▪ AMPLITUDE	20 V

Output Socket:

- Front panel OUTPUT

Synchronization:

- Rear panel SYNC 1 OUTPUT

Condition:

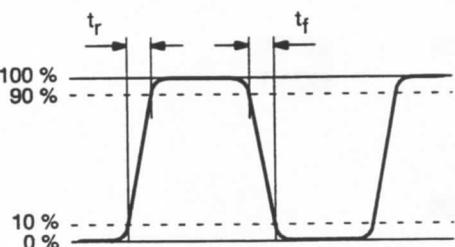
- Generator output 50 Ω terminated

Test requirement:

- $t_r, t_f < 20 \text{ ns}$

t_r = rise time

t_f = fall time



4.3.5 Input/Output Sockets Test

NOTE

RESET – ALL in the following procedure resets the waveform memory to its defined initial state. Stored Arbitrary Waveforms are so deleted. If signal waveforms are stored, which can only be reproduced with high effort, we recommend to read out the memory contents by a PC. So you can externally store the data in order to later re-load them into the PM 5150.

If you cannot use own application software, our PM 2273 WaveMaker, among further facilities, offers you a convenient tool for storing and re-loading waveforms.

Test Equipment:

- Oscilloscope set to high input impedance
- 50 W feedthrough termination

Generator Settings:

- 1. RESET RESET – ALL
- 2. SETUP STD WAVE SYNC 1,2,3 to ADDR mode
STD WAVE TRI
OUTPUT ON
- Connect the oscilloscope directly to the rear panel output sockets and verify that the following signals are present:

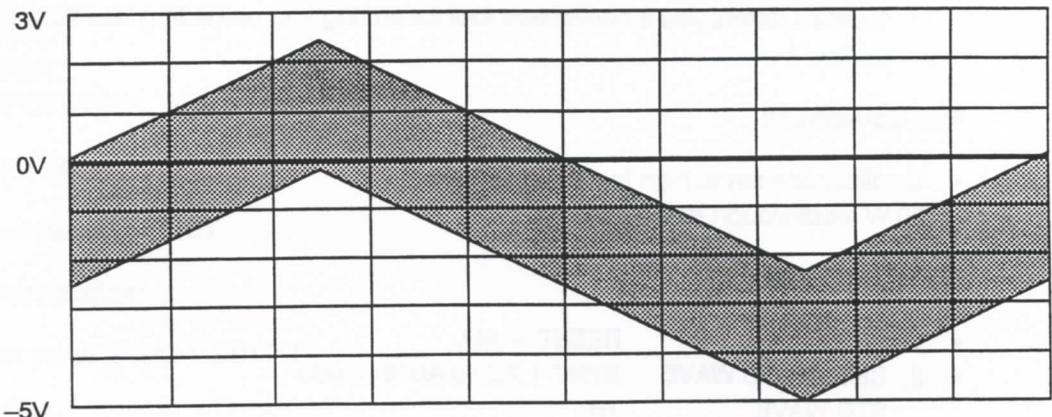
RCLK OUT:	TTL pulses with 10 MHz repetition rate	
SCLK OUT:	TTL pulses with 10 MHz repetition rate	
SYNC TRIG OUT:	100 ns TTL pulses with 10 kHz repetition rate	
SYNC 1 OUT:	100 ns TTL pulses with 10 kHz repetition rate	
Z-OUT:	instrument setting:	approximate voltage:
	STD WAVE	±0V
	ARB WAVE, ZLVL = 1500	+3V
	ARB WAVE, ZLVL = 1000	+2V
SYNC 2 OUT:	100 ns TTL pulses with 10 kHz repetition rate	
SYNC 3 OUT:	100 ns TTL pulses with 10 kHz repetition rate	

- Connect the oscilloscope to the front panel output via the 50Ω feedthrough terminator. Use the rear panel SYNC 1 OUTPUT to trigger the oscilloscope. The screen should display the standard triangular wave.

To check the rear panel input sockets, perform the following connections and view the oscilloscope screen.

SUM IN:

Connect SCLK output to SUM IN socket. The oscilloscope screen should change as shown in the following figure:



Signal on Screen of the Scope

TRIG IN:

Connect SCLK output to TRIG IN socket. Verify that the output signal changes to zero volts.

RTS IN:

Connect SCLK output to RTS IN socket. Verify that the output signal changes to zero volts.

HOLD IN:

Connect SCLK output to HOLD IN socket. Verify that the OUTPUT wave holds at any voltage between -2.5 and +2.5 V.

5 DISASSEMBLING THE INSTRUMENT

5.1 GENERAL INFORMATION

This section provides the disassembling procedures required for the removal of components during repair operations.

All circuit boards removed from the instrument must be adequately protected against damage, and all normal precautions regarding the use of tools must be observed.

During disassembling make a careful note of all disconnected leads so that they can be reconnected to their correct terminals when the instrument is reassembled.

CAUTION:

Damage may result if:

- The instrument is turned on when a circuit board has been removed.
- A circuit board is removed within one minute after turning off the instrument.

5.2 REMOVING THE COVERS

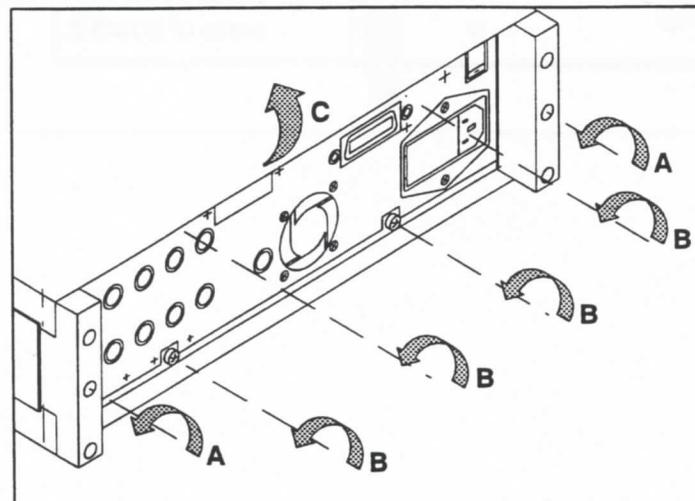
WARNING:

Removing the instrument covers or removing parts, except those to which access can be gained by hand, is likely to expose live parts, and also accessible terminals may be live.

To avoid electric shock, turn off line power and remove the power cord before disassembling the instrument.

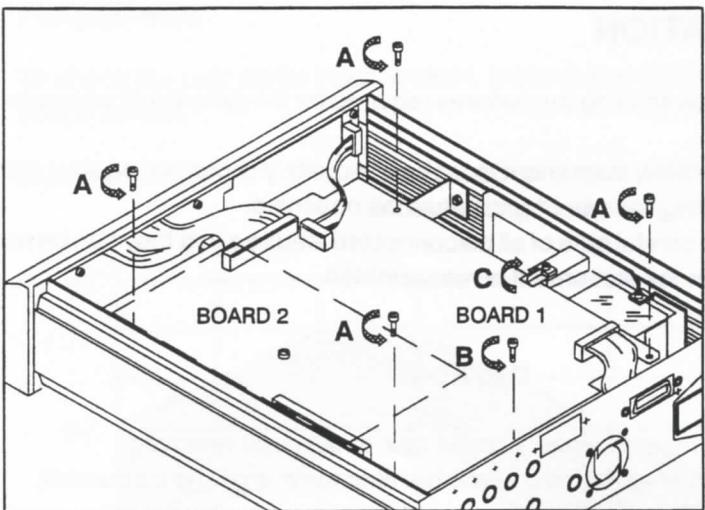
If adjustment, maintenance or repair of the disassembled instrument under voltage is inevitable, it shall be carried out only by qualified personnel using customary precautions against electric shock.

Capacitors inside the instrument may still be charged even after the instrument has been turned off or disconnected from the power supply.



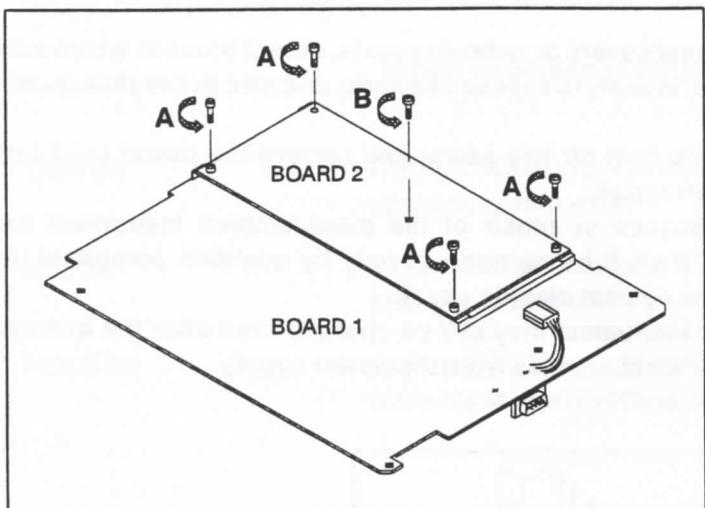
- Unscrew the two rear bumpers (A).
- Loosen the four rear screws (B).
- Remove top cover (C) and bottom cover.

5.3 BOARD 1



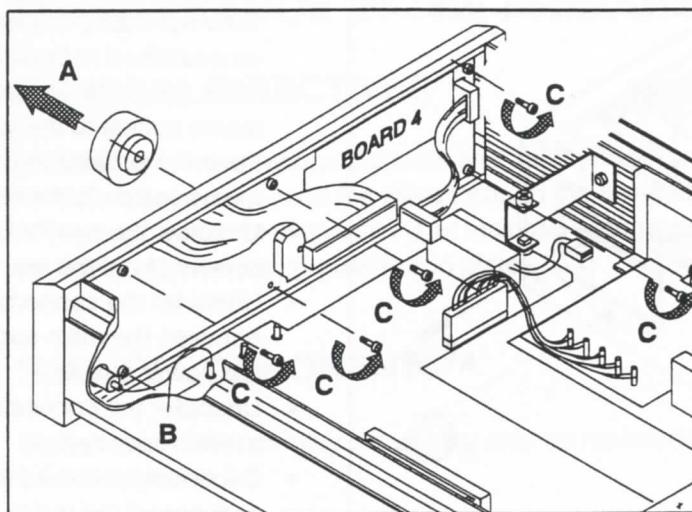
- Unplug plugs from board 1.
- Unscrew the four Phillips screws (**A**) at the four corners of the board.
- Unscrew the Phillips screw (**B**) near the rear wall.
- Unlock rotary lock (**C**).
- Cautiously lift board 1 a few centimeters at the rear wall and disconnect the connector to the board under that.
- Cautiously take board 1 out to the top.

5.4 BOARD 2



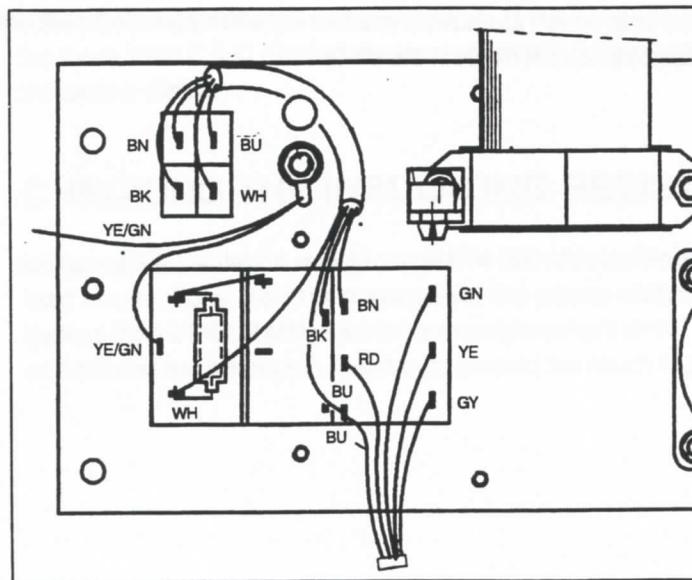
- Take out board 1 to the top as described in Section 5.3.
- Place board 1 onto a clean surface with board 2 facing to the top.
- Unscrew the four Phillips screws (**A**) at the four corners of board 2.
- Unscrew the Phillips screw (**B**) in the middle of board 2.
- Cautiously pull board 2 out of the two connectors at the smaller sides of board 2.

5.5 BOARD 4



- Take out board 1 to the top as described in Section 5.3.
- Cautiously pull off rotary knob (A) to the front.
- Unsolder coaxial cable (B) from the BNC socket inside the unit.
- Unscrew the six Phillips screws (C) of board 4.
- Cautiously pull out board 4 to the rear.

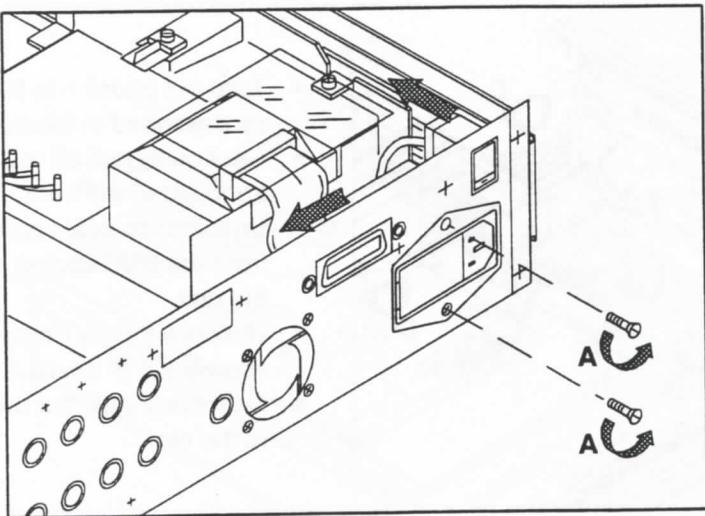
5.6 POWER SUPPLY



- Take out board 1 to the top as described in Section 5.3.
- Disconnect cable on board 3.
- Remove the connection cover from the mains socket.
- Desolder five wires at the mains socket.
- Unscrew four M3 nuts at the side panel.
- Remove the Power Supply.

The Power Supply is delivered with cable to board 3 and the five wires to the mains socket.

5.7 MAINS SOCKET AND SWITCH



- Take out board 1 to the top as described in Section 5.3.
- Push the protection cover for mains socket to the left side.
- Push the protection cover for mains switch to the front.
- Unscrew the two Phillips screws (A) of the rear wall.
- Unsolder the connections between the main socket and the power supply.
- Unsolder the connections at the mains switch.
- Cautiously pull out the mains socket and the mains switch.

5.8 TEXT PLATE

The text plate is an adhesive foil strip which cannot be reattached after you have remove it. Place a small screwdriver behind the foil strip and remove it carefully.

6 SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT

6.1 GENERAL DIRECTIVES

- Take care that creepage distance and clearances have not been reduced.
- Before soldering, bend the wires through the holes of the solder tags or wrap the wires round the tag in the form of an open U, or maintain wiring rigidity by using cable clamps or cable lacing.
- Replace all insulating guards and plates.

6.2 SAFETY COMPONENTS

Components in the primary circuit may only be replaced by components selected by Fluke/Philips, see also Section 7.3.

6.3 CHECKING THE PROTECTIVE GROUND CONNECTION

The correct connection and condition is checked by visual control and by measuring the resistance between the protective-lead connection at the plug and the cabinet/frame. The resistance shall not be more than 0.5Ω . During measurement the power cord should be moved. Resistance variations indicate a defect.

6.4 CHECKING THE INSULATING RESISTANCE

Measure the insulation resistance at $U = 500$ Vdc between the power connections and the protective lead connections. For this purpose set the power switch to ON. The insulation resistance shall not be less than $2 M\Omega$; $2 M\Omega$ is a minimum requirement at $40^\circ C$ and 95 % relative humidity. Under normal conditions, the insulation resistance should be much higher (10 to $20 M\Omega$).

7 SPARE PARTS, FIGURES

7.1 GENERAL

The complete instrument PM 5150 is repaired preferably in the Supply Center Hamburg. Only parts listed in chapters 7.8 to 7.10 are available as spare parts. For the Service Procedure see Chapter 3 of this manual.

7.2 STANDARD PARTS

Electrical and mechanical parts replacements can be obtained through your local Fluke/Philips organization or representative. However, many of the standard electronic components can be obtained from other local suppliers. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description.

NOTE: Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

7.3 SPECIAL PARTS

In addition to the standard electronic components, the following special components are used:

- Components, manufactured or selected by Fluke/Philips to meet specific performance requirements.
- Components that are important for the safety of the instrument are marked with 'S' in the parts list.

NOTE: Both type of components may only be replaced by components obtained through your local Fluke/Philips organization or representative.

7.4 BOARDS

Only the Power Supply and the Keyboard/Display Board are available as spare boards. The board set, consisting of the Analog Board 3, the Digital Board 1, and for instruments PM 5150/551 with the Sequencer Board 2 under the Digital Board, is not available as spare part.

7.5 STATIC-SENSITIVE COMPONENTS

This instrument contains electrical components that are susceptible to damage from static discharge. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.

7.6 HANDLING MOS DEVICES

Though all our MOS integrated circuits incorporate protection against electrostatic discharges, they can nevertheless be damaged by accidental overvoltages. In storing and handling them, the following precautions are recommended.

CAUTION

To avoid electric shock testing or handling and mounting call for special attention to personal safety. Personnel handling MOS devices should wear a ground strap.

7.7 SOLDERING TECHNIQUES

Working method:

- Carefully unsolder one after the other the soldering tags of the semiconductor.
- Remove all superfluous soldering material.
- Check that the tags of the replacement part are clean and pretinned in the areas where they are to be soldered.
- Locate the replacement semiconductor exactly in its place, and solder each tag to the relevant printed conductor on the circuit board.

NOTE: Bear in mind that the maximum permissible soldering time is 10 seconds during which the temperature of the tags must not exceed 250 °C. The use of solder with a low melting point is therefore recommended. Take care not to damage the plastic encapsulation of the semiconductor (softening point of the plastic is 150 °C).

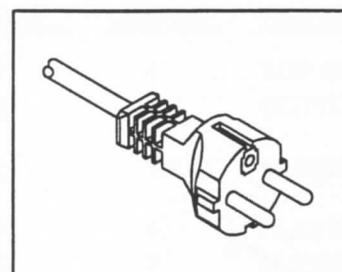
WARNING

When you are soldering inside the instrument, it is essential to use a low-voltage soldering iron, the tip of which must be grounded to the instrument.

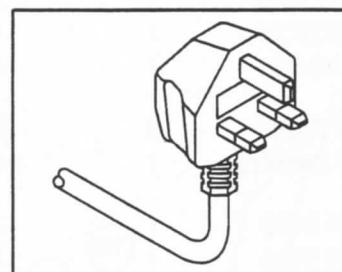
Suitable soldering irons should have temperature control and different types of nozzles (pin point tips), e.g., Weller Magnastat WTCP or WECP, Ersa TC 70/24V.

If a higher wattage-rating soldering iron is used on the etched circuit boards, excessive heat can cause the etched circuit wiring to separate from the board base material. In general use short-time heating with tip temperature at a small point; avoid long time heating.

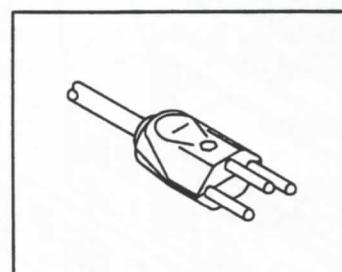
7.8 MAINS CABLES



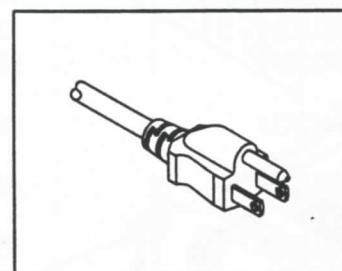
Universal Europe
5322 321 10755



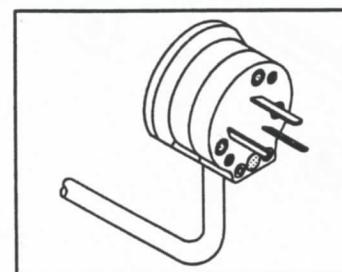
England, U.K.
5322 321 10756



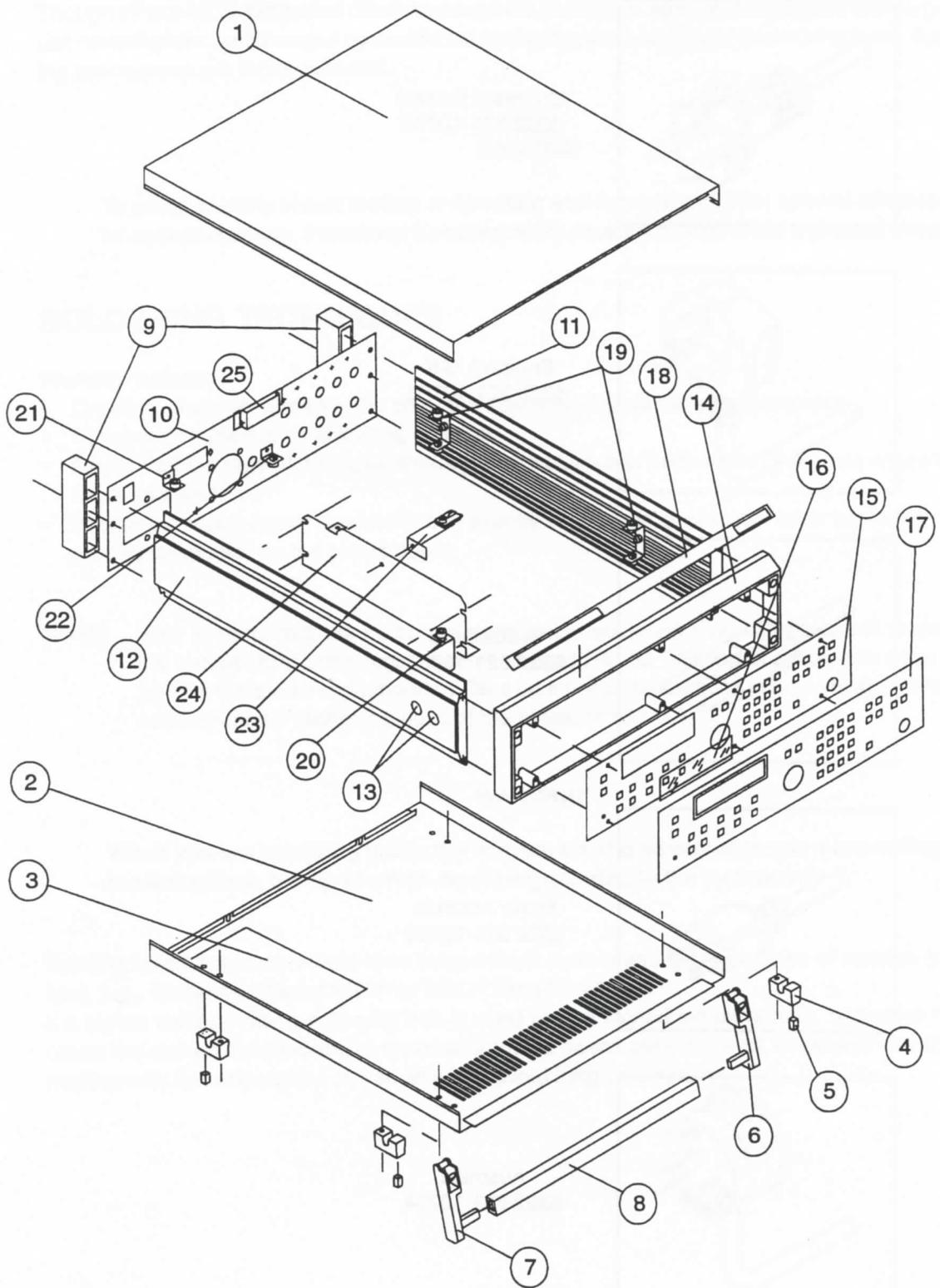
Switzerland
5322 321 10753



North America
5322 321 10752

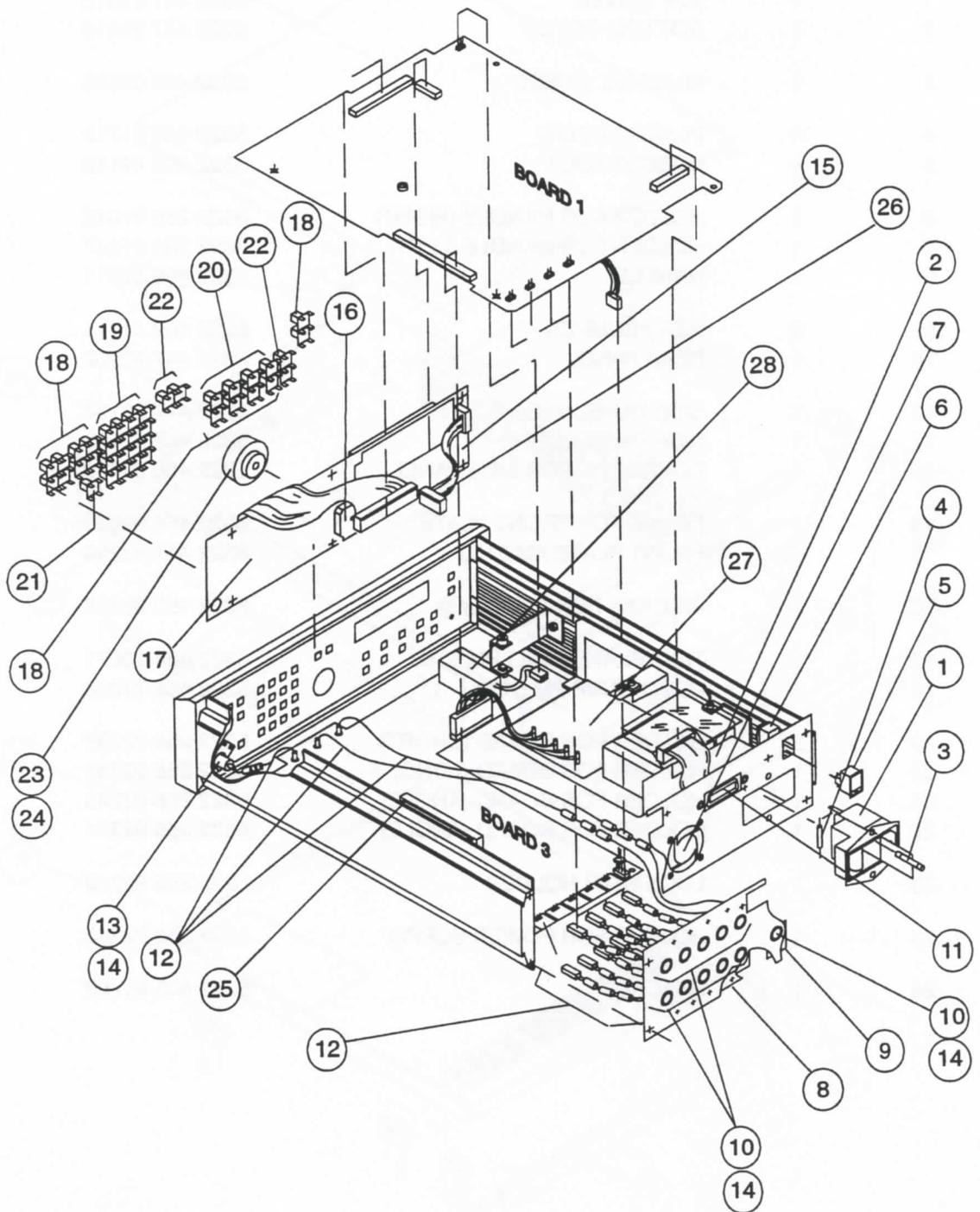


Australia
5322 321 10754



7.9 MECHANICAL PARTS, HOUSING (Figure 30)

<u>Item</u>	<u>Quantity</u>	<u>Description</u>	<u>Ordering Code</u>
1	1	TOP COVER	5322 447 91915
2	1	BOTTOM COVER	5322 447 91818
3	1	MUMETAL SHEET	5322 466 62565
4	4	PLASTIC FOOT	5322 462 41712
5	4	RUBBER FOOT	5322 462 44148
6	1	HOLDER FOR HANDLE (RIGHT)	5322 256 91648
7	1	HOLDER FOR HANDLE (LEFT)	5322 256 91647
8	1	HANDLE	5322 498 50311
9	2	REAR BUMPER	5322 462 41711
10	1	REAR PANEL	5322 447 92282
11	1	SIDE PANEL (RIGHT)	5322 447 92164
12	1	SIDE PANEL (LEFT)	5322 447 92163
13	4	COVER PAD FOR SIDE PANEL	5322 466 62439
14	1	FRAME FOR FRONT PLATE	5322 464 90663
15	1	FRONT PLATE PM 5150	5322 447 92283
16	1	WINDOW FOR DISPLAY	5322 450 62316
17	1	TEXT PLATE (FOIL) PM 5150	5322 466 10671
18	1	LOGO STRIP PM 5150	5322 455 71098
19	2	HOLDER FOR BOARD (SHORT)	5322 256 92239
20	1	HOLDER FOR BOARD (LONG)	5322 256 92241
21	1	HOLDER FOR BOARD (ANGLE)	5322 256 92245
22	1	HOLDER FOR BOARD (ANGLE)	5322 256 92244
23	1	LOCK WITH HOLDER	5322 256 92243
24	1	HOLDER FOR POWER SUPPLY	5322 256 92242
25	1	BRACKET	5322 405 91709



7.10 MECHANICAL PARTS ON UNITS, CABLES, WIRES (Figure 31)

<u>Item</u>	<u>Quantity</u>	<u>Description</u>	<u>Ordering Code</u>
1	1	MAINS SOCKET WITH VOLTAGE SELECTOR AND LINE FILTER	S 5322 121 43938
2	1	PROTECTION COVER FOR MAINS SOCKET	S 5322 462 41709
3	1	FUSE 500 mA/250 V	S 4822 070 35001
	1	FUSE 250 mA/250 V	S 4822 070 32501
4	1	HIGH VOLTAGE RESISTOR 4.7 MΩ	S 4822 053 20475
5	1	MAINS SWITCH	S 5322 276 12029
6	1	PROTECTION COVER FOR MAINS SWITCH	S 5322 462 41708
7	1	FAN	5322 361 10723
8	1	GROUNDING UNIT PM 5150	5322 214 91462
9	1	EMC UNIT	5322 214 91391
10	11	BNC CONNECTOR KC-79-46	5322 267 10173
11	1	IEEE CONNECTOR WITH CABLE	5322 321 62659
12	1 SET	MINI-COAX CABLES WITH EACH 3 FERRO-MAGNETIC CORES (2 PIECES 400 MM AND 1 PIECE 100 MM), 4 TWISTED WIRES WITH EACH 3 FERRO-MAGNETIC CORES 65 MM, 5 TWISTED WIRES WITH EACH 3 FERRO-MAGNETIC CORES 55 MM	5322 321 62656
13	1	RF BNC CONNECTOR	5322 267 10004
14	13	SLEEVE FOR BNC CONNECTOR	5322 532 51309
15	1	KEYBOARD COMPLETE WITH DISPLAY, ROTARY ENCODER	5322 218 80997
16	1	ROTARY ENCODER	5322 273 20388
17	39	PUSHBUTTON	4822 276 11076

<u>Item</u>	<u>Quantity</u>	<u>Description</u>	<u>Ordering Code</u>
18	14	CAP FOR PUSHBUTTON GREY	5322 414 60707
19	16	CAP FOR PUSHBUTTON LIGHT GREY	5322 414 70188
20	4	CAP FOR PUSHBUTTON LIGHT BLUE	5322 414 70192
21	1	CAP FOR PUSHBUTTON ORANGE	5322 414 70189
22	4	CAP FOR PUSHBUTTON DARK GREY	5322 414 70191
23	1	KNOB GREY	5322 414 60708
24	1	CAP FOR KNOB	5322 414 70125
25	1	CONNECTION CABLE BOARD 1 – BOARD 3	5322 321 62657
26	1	CONNECTION CABLE KEYBOARD – BOARD 1	5322 321 62658
27	1	POWER SUPPLY WITH TRANSFORMER MOUNTING PLATE, CABLES	5322 219 10573
28	1	BACKUP BATTERY WITH CABLE	5322 138 10573

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